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The Origin and Distribution of the Loess-Like Material in the Vicinity of Urbana

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THE ORIGIN AND DISTRIBUTION OF THE LOESS-LIKE MATERIAL IN THE VICINITY OF URBANA

BY

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THESIS

Submitted in Partial Fulfillment of the Requirements for the

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I. INTRODUCTION

In the vicinity of Urbana, Illinois, a loess-like silt mantles the drift.[1] This silt mixed with humus forms not only the rich soil of the productive corn belt of Illinois, but in most places the subsoil as well. It is not confined to the immediate vicinity of Urbana but it is found widely distributed over the glaciated areas of this and adjoining states. In this thesis an attempt is made to explain its origin and to account for its thickness and its areal distribution.

Geologists who have done work in the glaciated areas of Illinois and adjacent states have recognized a mantle similar in character to the material of the surface layer at Urbana and have called it loess.[2] They have not, however, deduced any cause for its variation in depth over the areas studied. The University of Illinois Agricultural Experiment Station under the direction of Cyril G. Hopkins and James H. Petit has made an extensive study of the soils of Illinois but only to a depth of seven inches and has not considered their origin.[3]

II. PHYSIOGRAPHY AND GEOGRAPHY OF THE URBANA REGION

Urbana, the center of the region under consideration lies in latitude 40°7' North and longitude 88°5' West. The region is wholly within the Mississippi Basin and has an average elevation of 720 feet above sea level. It is also within the

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[1] Fenneman, N. M., Ill. State Geol. Survey Bulletin 12, "Physiog. of the St. Louis Area," pp. 6-8.

[2] Carman, J. E., Ill. State Geol. Survey Bulletin 13, "The Miss. Valley Between Savanna and Davenport".

[3] Hopkins, C. G., and Petit, J. H., Univ. of Ill. Agr. Exp. Sta. Bulletin 123, "The Fertility in Ill. Soils", p. 195.

region that was glaciated by the earlier Wisconsin ice Advance, but it lies within the lower limits of that area and was therefore the scene of deposition rather than of erosion. The deposition of glacial debris by filling in hollows converted a region of possibly mature topography into an exceedingly flat plain, broken only occasionally by glacial hummocks, or by the occasional recessional moraines which form rather low rounded swells on the flat plains.

The area is drained by small tributaries of the Vermillion, Sangamon and Kaskaskia rivers which flow radially away from Urbana as a center. The drainage is poor and swampy conditions would to a large extent prevail were the land not artificially drained to make it fit for agriculture. Dissection to any great extent occurs only along the main branches of the larger streams, where because of the non-resistant nature of the drift, the larger rivers found little difficulty in wearing down their beds to grade, forming at the same time the characteristic steep-sided valleys of youthful topography. The divides between the stream courses are exceedingly flat and the region as a whole presents a remarkably even sky-line. Another noticeable feature of the surface is the frequency of small depressions existing among surrounding small billowy drift hummocks representing the uneven deposition of the ground moraine. These depressions, however, are being filled up by sediments washed down from surrounding low elevations during excessive rains.

The average annual precipitation of the region is approximately 37 inches coming in the form of both rain and snow.[1] Since a large amount of this moisture comes in the form of snow and in slow drizzling downfalls of rain, a smaller amount of erosion is accomplished than in regions where frequent heavy downpours of rain occur. The region has a climate closely approaching the typical continental. The summers are hot and endure for a period of about four months. Temperatures of 100° F. and above are often reached. The winters, equally long, are cold and a temperature as low as -15° F. is common.

The region under consideration lies in the belt of winds known as the Westerlies and the prevailing winds blow from the southwest. The wind often acquires a velocity of from 20 to 30 miles per hour. A glance at a map will show that this region is in the direct path of winds coming from the deserts and the dry high plains of Western United States, and that it also lies in the path of the winds which sweep the silt-covered floodplains of the Missouri and Mississippi rivers.

The fertility of the soil, abundant rainfall and the warm temperature of the summers make this region favorable for a rather luxuriant and hardy vegetation. Upland and lowland alike are covered with a luxuriant growth of grass where the area is uncultivated. Deciduous forests of maple, elm, hickory, oak, etc., are not uncommon, and before the region was settled

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[1] Weather Observ. Dept. of Agr., Univ. of Ill.

and cleared they were quite extensive. This region is also the abode of burrowing rodents such as the field mouse, gopher, chipmunk, etc. Ants that make their homes in excavations in the ground are exceedingly numerous. Crayfish and beetles also burrow into the soil marking their homes with little mounds of dirt. The angle worm is perhaps in greater abundance than any other faunal organism in the region.

III. LOESS-LIKE MATERIAL IN THE VICINITY OF URBANA

Mantling the drift in the vicinity of Urbana is a fine, mealy, powdery substance consisting largely of undecomposed rock and mineral fragments among which are chiefly feldspar, hornblende, and quartz. It varies in color from light brown through dark brown nearly black. It is entirely absent in places, but in others reaches a depth of over six feet. When exposed vertically it forms perpendicular walls and cliffs and because of irregular cleavage or of shrinkage joints developed in the material there is a tendency for the substance to assume a columnar structure. A fine illustration of this may be seen at the large limestone quarry south of Fairmount, Illinois, where a vertical exposure five or six miles in extent occurs. This loess-like material is never found stratified although it often overlies stratified sand, silt and gravels. It contains occasional small pebbles which were in all probability brought up from the underlying drift by burrowing rodents. Concretions of any kind are absent. An occasional boulder is found which is probably due to the lifting action of frost.

IV. DISTRIBUTION AND DEPTH OF LOESS-LIKE MATERIAL ABOUT URBANA

The depth of this loess-like mantle varies as the following table will show.

Rantoul District

Location	Depth of Loess	Notes on Topography
1. 200 feet north of Illinois Central water tank.	No loess on top. At 20 inches found some loess.	Low ground. Probably reworked in railroad construction.
2. 1000 feet north of Illinois Central tracks east and west and just east of tracks north and south.	30 inches.	Level surface.
3. Top of knoll one-half mile north of Rantoul.	No loess.	Evidences of erosion present.
4. Just north of cemetery one mile north of Rantoul.	24 inches.	High flat surface.
5. Just north of location No. 4.	24 inches.	Lower than above, stratified gravel and sand underneath.
6. Top of first knoll on high part of moraine.	20 inches	Flat topped knoll - little or no erosion taking place.

Danville District

7. West bank of river at Mission Ridge	Average depth 28 inches.	Flat surfaces where little erosion had occurred.
8. Sides of gullies at Mission Ridge	No loess.	Drift everywhere exposed.
9. Front of farm house at head of longest east gulley.	8 inches.	Some erosion had occurred, but was just actively commencing.

Danville District (Continued)

Location	Depth of Loess	Notes on Topography
10. East bank of river at Mission Ridge.	Average depth 18 inches.	Flat topped knoll.
11. Second farm house east from river south of Illinois Traction System track.	27 inches.	Flat surface.
12. Gullies east and south of Mission Ridge.	No loess.	Extensive erosion.

Fairmount District

Location	Depth of Loess	Notes on Topography
13. Along quarry.	60-72 inches	Flat surface.
14. Going north along road east of quarry, at culvert.	No loess.	Extensive erosion.
15. 1000 feet north of culvert.	24 inches.	Very gentle slope.
16. Midway between culvert and highest part of moraine.	27 inches .	Very gentle slope.
17. Highest part of moraine.	28 inches.	Flat surface - no erosion.
18. In yard of farm house north of road on highest part of moraine.	26 inches	Flat surface.
19. 1000 feet north of farm house at north gate.	26 inches.	Flat surface.
20. 400 feet south of Fairmount.	28 inches.	Flat surface.

Mattoon District

Wisconsin Terminal Moraine

Location	Depth of Loess	Notes on Topography
21. East of Illinois Central tracks on high part of moraine.	No loess.	Showed evidences of erosion.
22. 1000 feet north of 21.	13 inches.	On gradual slope.
23. 2000 feet north of 22.	26 inches.	Rather level.
24. Knoll 1/2 mile east of tracks and 1/2 mile south of Mattoon	No loess.	Erosion apparent.

Mayview District

Location	Depth of Loess	Notes on Topography
25. 1/4 mile south of Mayview.	40 inches.	Very flat surface.
26. 1 mile east and 1/4 mile south of Mayview.	27 inches.	Slight slope.
27. 1/2 mile north west of Mayview.	22 inches.	Medium slope.
28. 3/4 mile north east of Mayview.	21 inches.	Top of flat topped knoll.
29. 1 mile north and 1/2 mile west of Mayview on road side.	22 inches.	On gradual slope of valley side of Salt Fork.
30. 1/2 mile north and 1/4 mile west of Mayview.	40 inches.	Very flat and level surface.

Hillery District

Location	Depth of Loess	Notes on Topography
31. 1/2 mile north of Hillery along road.	42 inches.	Plain topography.

Hillery District (Continued)

Location	Depth of Loess	Notes on Topography
32. 7/8 mile north of Hillery.	72 inches.	No erosion taking place.
33. 1 1/2 miles north of Hillery.	36 inches.	Slightly eroded.
34. 3 3/4 miles north of Hillery on highest part of ridge.	52 inches.	Rather flat. Little or no erosion occuring.
35. 4 1/4 miles north of Hillery	48 inches.	Plain topography.

Urbana District

36. One mile south of Court house.	22 inches.	Some erosion taking place.
37. 1 1/8 miles south of Court house and 1/8 mile west.	40 inches.	Flat topped knoll.
38. 1 mile east of cemetery and 1/4 mile south.	42 inches.	Depression between two knolls.
39. On road 1/2 mile east of cemetery running north and south.	42+ inches at various intervals.	Flat topography.
40. 2 miles south of Court house.	0	Rather steep sided knoll greatly eroded.

From this table it will be seen that a rather comprehensive study of the depth and distribution of the loess-like mantle in the area under consideration has been made. A special effort was made to select places for study widely distributed and to study the depth of the mantle on all the physiographic land forms in the region. The conditions that prevail in general throughout the Urbana region in regard to the depth and distribution of this material are as follows:

In valleys where any considerable erosion has occurred no loess can be found. Where erosion in valleys has baan only moderate or has practically just commenced a proportionate amount of loess may be found. In the little depressions, however, which abound, surrounded by small elevations, and which have been the receptacles for the wash from these surrounding hillocks the loess often reaches depths of over 6 feet. The higher elevations also show a depth of the loess proportional to the amount of erosion that has occurred. On some of the more pronounced hills the till is exposed; on other flat topped knolls where erosion has been less active the depth of the loess averages approximately two feet. On hillsides and the sides of valleys the loess is absent if the slope is great and is present if the slopes are moderate. On the flat topped divides and the extensive plains the greatest depth of the loess-like material is found and a remarkably uniform thickness of about 40 inches prevails. From this it may be safely concluded that the loess tended or tends (whatever its origin) to establish itself over the surface

to an approximately uniform depth, but that its present depth at any particular locality is dependent entirely upon the amount of erosion that has occurred there.

V. THE ORIGIN OF THE LOESS-LIKE MATERIAL ABOUT URBANA

Typical loess has been defined by Chamberlain and Salisbury as follows: [1]"Loess is a variety of silt intermediate between the finest sand and clay. In general it is free from stones of all sorts, except concretions which have been developed in it since its deposition."

[2]"In its most typical phase the loess is fine grained. When dry it forms a powder, smooth to the feel and without grit of any sort."

[3]"The composition of the loess is significant in that it contains angular undecomposed particles of the commoner carbonates, calcite and dolomite and silicates such as the feldspars, amphiboles and micas, etc."

These definitions include all the characteristics of the material found at Urbana except that it is free of concretions. Since eolian origin is not stated as essential in the definition of loess and because of the similarity of the Urbana material to loess, it will hereafter be referred to as loess.

As to the origin of this mantle, Professor J. A. Udden and others have considered such a mantle in the Mississippi valley to be loess and have considered it as a land deposit,

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[1] Chamberlain and Salisbury. Geology. Advanced Series, p. 403.
[2] Carman, J. E. Ill. State Geol. Survey Bulletin 13. The Miss. Valley Between Savanna and Davenport, p. 69.
[3] Sixth Annual Report, U. S. Geol. Survey, p. 214.

its presence being due to the existence of flat uplands where little or no erosion occurs to carry it away as fast as it is deposited from the atmosphere.[1]

Professor T. C. Chamberlain explains the presence of the loess as being due to a combination of aqueous and aeolian action.[2]

Fuller and Clapp who have made an extensive study of the loess have the following to say: "The time for generalization as to origin of the loess as a whole from observations in a single region appears to have passed, and the origin in each locality is best decided for itself by its own internal or physiographic evidence."[3]

This appears to be a very rational view in this much discussed controversy. Acting upon their suggestion, this point of view will be maintained in this discussion, it being understood of course that causes which operated here are not necessarily restricted wholly to this area but may be applied elsewhere as conditions warrant.

It has been suggested that this loess-like mantle which covers the drift of the Urbana region is due to the deposition of silt in lakes that are assumed to have resulted from the Wisconsin ice advance. This theory may be discarded, however, first because of the absence of proof that these lakes ever existed for a sufficient length of time to account for the depth

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[1] Udden, J. A. "Loess as a Land Deposit." Bulletin Geol. Soc. Am. Vol. 9, 1897.

[2] Ill. State Geol. Survey, Bulletin 13.

[3] Fuller, M. L. and Clapp, F. G. "Marl-loess of the Lower Wabash Valley." Geol. Soc. Am. Bulletin 14, 1903, p. 174.

of the sediments throughout the area. Second because this material lacks the characteristics of lake bottom deposits. In the few places, however, where there is evidence of former small kettle-hole lakes, lake deposits consisting largely of marl, clays or a highly carbonaceous loam,and not loess-like material are recognizable. The impossibility of recognizing any traces of former shore lines shows that these assumed moraine-dammed lakes were only of a transient nature and did not persist long enough to develop lasting features of wave action. It is also quite inconceivable that there could have existed, above the level of any former large lakes, slopes extensive enough and steep enough to have furnished sufficient sediments to have produced such a mantle as at present overlies the region.

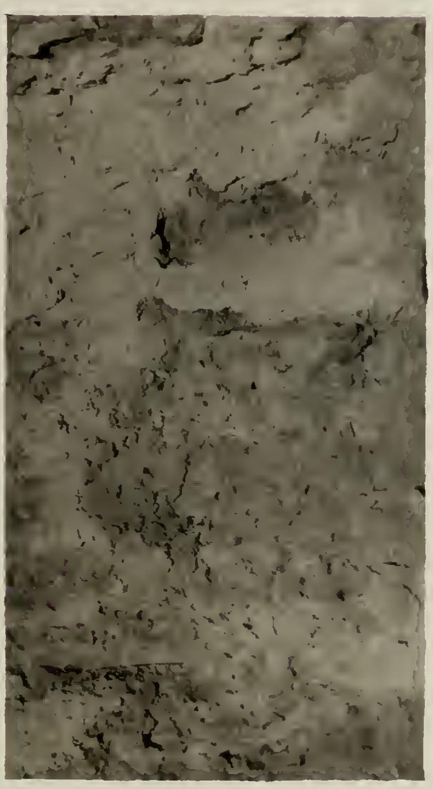
Finally the loess is found upon the highest elevations in the region as well as in the lowest depressions. These elevations are the highest parts of the moraines which are assumed to have formed the dams that held in the temporary lakes. Because of this fact the loess on the highest elevations, which must have protruded above the surface of the water can not possibly be a water-lain deposit.

The loess in North America has usually been considered to have had its origin in the pulverizing action of the glaciers that swept over the northern part of the continent. The resulting powdered material is supposed to have been swept out of the glacier by the waters from the melting ice into numerous outwash

and flood plains, from which, after drying, it was transported by the wind and deposited over the surrounding country. Microscopic examination reveals the fact that the drift contains a vast amount of finely powdered material produced by the grinding action of the glacier and it seems entirely probable that the glacier-fed streams contained more silt than is carried by the ordinary streams of the present. A considerable amount of the loess, particularly along the margin of stream courses, was probably produced in this way. However, if all the loess originated in this way as much material must have once existed as flood plain material as now exists as loess in our loess-covered areas. This seems highly improbable for had this actually been the case, we should be able to find at least remnants of these extensive deposits of silt and flood plain material. The entire supply may be assumed to have come from the flood plain of some large river such as the Mississippi whose supply of loess-silt is practically inexhaustible, but it must be borne in mind that the flood plain of such a river is usually swampy and covered with dense vegetation, and it is doubtful whether as much silt actually is transported from such river valleys as is often assumed. Had it come entirely from the deserts of Western United States, the chances are that it would not be as angular as it is, nor would the particles be as large. In view of the direction of the prevailing westerly winds and the situation of the Urbana region with respect to the Mississippi flood plain and the Western Deserts it seems certain that some small proportion of the loess

of Urbana must have been derived from these sources.

There is, however, another agent, first suggested to me by Dr, John G. Rich, which seems entirely capable of having produced this loess mantle, and which it is believed has been more important that any of those already mentioned. As was previously stated the earthworm is remarkably abundant and prolific in this area. The amount of material that is brought to the surface by this especially active worker is apparent only to the careful student. These little mounds, often averaging in number from eight to ten per square foot and renewed after every considerable rain each contain approximately one-twentieth of a cubic inch of loess. They are usually concealed by grasses and other vegetation and are unnoticed by the casual observer. The earthworms operate at depths as great as six feet below the surface, and besides merely burrowing through the ground they make small spherical cavities at various depths as the accompanying photograph will show.



Photograph showing worm channels and excavations. The dark spots are cavities,- the lower ones being over six feet beneath the surface. The numerous small round dark spots represent the channels.

Earthworm heaps, University of Illinois Campus. From one square foot of ground here, selected at random, 12 grannes of soil were collected as a result of a single night's work on the part of the worms. This may represent a greater concentration than the average on account of the proximity of the sidewalk.

These excavations are apparently their homes, and range in size from three-fourths to one inch in diameter. The material resulting from these excavations and channels is carried to the surface and forms the little earthworm mounds which are extremely numerous wherever the earthworm is abundant. In the vicinity of Urbana earthworms are especially active even at depths as great as six feet. In this zone, which often included the upper part of the drift, the earthworms with their subterranean channels perforate the loess and till in all directions, and cover the surface with material which they bring up from below. Shaler, who has made a careful study of the work of earthworms on soil, states that earthworms will bring sufficient material to the surface annually to make a layer 1/10 of an inch in thickness.[1] At this rate, assuming the average depth of the loess at Urbana to be forty inches it would have taken but four hundred years for the worms to build up the mantle overlying the drift in this region. Actually it must have taken much longer because the material after reaching a certain depth is constantly being reworked, and only occasionally is new material added. Wherever erosion is active, fine material would disappear as fast as the worms could bring it to the surface and no thick deposit could accumulate. Erosion, however, is extremely slight on the plains surrounding Urbana so that a considerable accumulation of the material carried up by earthworms is possible.

In order to secure some typical material assorted from

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[1] Shaler, N. S. The Origin of Soils. XII Ann. Report, U. S. G. S.

the drift by earthworms, approximately one hundred worms were placed in a box containing as typical glacial till as could be secured. In the course of a few weeks the earthworms had completely channelled the drift and brought to the surface large amounts of material - the results of their excavation. This material was then compared with the loess at Urbana. A large number of measurements of both substances were taken. In the following table a small number of these measurements are given to show the variation in size and the maximum size of both substances. Both materials grade down to particles too small to measure.

Loess of Urbana	Typical Earthworm Material
.0075 m. m.	.0045 m. m.
.0045	.0135
.0075	.0060
.0015	.0045
.0060	.0600
.0510	.0030
.0135	.0375
.0060	.0105
.0120	.0030
.0030	.0120
.0030	.0105
.0060	.0045
.0630	.0045
.0300	.0300
.0090	.0375
.0045	.0045
.0015	.0045
.0105	.0015
.0075	
Ave. .0130 m. m. Max. .0630	Ave. .0140 m. m. Max. .0600

It will be seen from this that the particles vary considerably in size. A maximum is reached but there is no tendency towards evenness in the size of the particles composing either material. The average obtained from these sample portions of the measurements that were taken is .0130 m. m. for the Urbana Loess and .0140 m. m. for the Typical Earthworm Material, but from the larger number of measurements that were taken an average if .0110 m. m. for the typical worm material, and of .0113 m. m. for the Urbana Loess was obtained. There is a difference of only .0003 between the two averages and this might easily be due to inaccuracies in measurement. No differences in angularity, composition, or size of particles between this Typical Earthworm Material and Urbana Loess can be discovered. Both substances are composed of decidedly angular fragments. Had they suffered transportation by wind or water or both, this angularity would in all probability have been lost to some extent at least because of attrition by particles while enroute. Because of their similarity and because of the fact that the worms actually work through the loess and into the underlying drift, and must have done so to a greater extent than at present when the loess was much thinner than it is now, it is highly probable that the earthworms are responsible for a large portion of the loess in the Urbana region. Another fact that strengthens this theory is that the loess from the bluffs of the Mississippi river in Calhoun County, Illinois, which is without doubt a wind deposit blown from the flood plain below, is decidedly less an-

gular, showing the effects of water and wind tranportation. This loess also tends to have a greater uniformity in the size of particles showing the sorting action of the wind. The average size of this Mississippi river bluff loess is .0173+, which is considerably coarser than the Urbana loess. If this material at Urbana were atmospheric dust it would be of a more uniform size, and in all probability would be much finer than is the average of the present loess, because of the inability of the atmosphere to hold in suspension or to carry for great distances large amount of large sized particles. Professor R. D. Salisbury found 96% of 87, 135 particles of Kansas City loess had diameters not exceeding .0025 m. m.[1] This is unquestionably aeolian loess. The extremely fine particles found in the loess at Urbana may have been derived in part from this latter source, but this is believed to form only a very small quantity in the bulk of the entire material.

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[1] Chamberlain, T. C. and Salisbury, R. D. The driftless Area of the Upper Miss. Sixth Annual Rept. U. S. Geol. Survey, 1885, p. 281.

VI. CONCLUSIONS

1. The material covering the drift about Urbana is loess.

2. The loess is present over the entire Urbana region except where erosion has occurred due to steep slopes or along stream courses.

3. In our opinion the importance of the theory explaining the origin of loess in the post-glacial era of flood plains has been exagerated.

4. The prevailing Westerlies have brought in some loess from the Western deserts and from some of the silt deposits across which they blow, but this is believed to be relatively unimportant.

5. Earthworms by reworking the glacial drift and by constantly bringing the finer elements to the surface and there leaving them are largely responsible for the loess in the Urbana region.

ACKNOWLEDGEMENTS

To Dr. John L. Rich of the University of Illinois at whose suggestion, and under whose direction this thesis was prepared, the writer is especially indebted for valuable suggestions and helpful criticisms. Thanks are also due to Mr. C. S. Ross for aid in microscopic examination and measurement of loess specimens.

BIBLIOGRAPHY

Carman, J. E., Ill. State Geol. Survey Bulletin 13, The Miss. Valley Between Savanna and Davenport.

Chamberlain, T. C. and Salisbury, R. D. The Driftless Area of the Upper Miss. Sixth Annual Rept. U. S. Geol. Survey, 1885, p. 281.

Fenneman, N. M., Ill. State Geol. Survey Bulletin 12, Physiog. of the St. Louis Area, pp. 6-8.

Free, E. E., U. S. Dept. of Agr. Bureau of Soils, Bulletin 68, The Movement of Soil Material by the Wind.

Fuller, M. L. and Clapp, F. G., Marl-loess of the Lower Wabash Valley. Geol. Soc. Amn. Bulletin 14, 1903, p. 174.

Gilbert, G. K., Wind-Drift Erosion. Amer. Jour. Sci. (3) Vol. 9: 151-152. (1875)

Hershey, O. H. The Upland Loess of Mo. Amer. Geol. Vol. 25, pp. 369-374. (1900)

Hopkins, C. G. and Petit, J. H. Univ. of Ill. Agr. Exp. Station Bulletin 123. The Fertility in Ill. Soils.

Hughes, Thos. M. Notes on Earthworms. Nature. Vol. 30, pp. 57-58. (1884)

Huntington, E. The Pulse of Asia. (1907)

Keyes, C. R. Eolian Origin of Loess. Amer. Jour. Sci. (4) Vol. 6, p. 299-304. (1898)

Knight, Nicholas. Analysis of Mt. Vernon Loess. Amer. Jour. Sci. (4) Vol. 13, p. 325. (1902)

Leverett, Frank. The Loess and its Distribution. Amer. Geol. Vol. 33, pp. 56-57. (1904)

Lindsey. Edward. A Reddish-Brown Snowfall. Science, N. S. Vol. 19, p. 893. (1904)

Milne, John. Quarternary Deposits. Amer. Geol. Vol. 3, pp. 345-361. (1889)

Prior, G. T. Dust Collected During a Thunderstorm in Galita Channel Mediterranean. Nature, Vol. 60, p. 205. (1899)

Reagan, A. B. The Blowing of Soils. Science, N. S. Vol. 28, pp. 653-654. (1908)

Richthofen, F. P. W. On the Mode of Origin of Loess. Geol. Mag. Vol. 9, pp. 293-305. (1882)

Russel, I. C. Subaerial Deposits of the Arid Regions of North America. Geol. Mag. Vol. 6, pp. 289-295, 342-350. (1889)

Shaler, N. S. U. S. Geol. Survey. Twelfth Amn. Rept. The Origin of Soils., pp. 213-345. Part I.

Udden, J. A. Loess as a Land Deposit. Bulletin Geol. Soc. Am. Vol. 9, 1897.

Udden, J. A. Erosion, Transportation and Sedimentation Performed by the Armosphere. Jour. Geol. Vol. 2, pp. 318-332. (1894)

Winchell, N. H. Loess in Minn. Am. Jour. Sci. 3rd Ser. Vol. 17, pp. 168-170.

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